television bulletin

ONTARIO DEPARTMENT OF EDUCATION

TEN-MINUTE PROGRAMS - THE HISTORY OF MATH

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THE HISTORY OF MATH - a series of 8 programs of 10 minutes each for students in the grades 7 to 10.

PROG. NUMBER	CBC 9:30	CBC REPEAT	CBOT 9:50	CBOT REPEAT 9:50	CHCH 9:50	CHCH REPEAT	CJOH CJSS 9:50	CJOH CJSS REPEAT
1	Jan.10 (10:20)		Feb. 1	Apr. 4	Oct. 31	Feb. 13	Oct. 24	Feb. 6
2	Jan. 17 (10:20)	Apr. 3 (10:20)	Feb. 8	Apr. 11	Nov. 7		Oct. 31	
3	Jan. 24 (10:20)	Apr. 10 (10:20)	Feb. 15	Apr. 18	Nov. 14		Nov. 7	
4	Jan. 31 (10:20)	Apr. 17 (10:20)	Feb. 22	Apr. 25	Nov. 21		Nov. 14	
5	Feb. 12		Feb. 29		Nov. 28		Nov. 21	
6	Feb. 26	Apr. 24 (10:20)	Mar. 7		Jan. 16		Jan. 9	
7	Mar. 11	May 1 (10:20)	Mar. 14		Jan. 23		Jan. 16	
8	Mar. 25	May 8 (10:20)	Mar. 28		Feb. 6		Jan. 30	

1. THE HISTORY OF π

Program Content

For circular objects, man noticed that when the measure of the circumference was divided by the measure of the diameter, the value obtained was the same. Early attempts to obtain the value of this ratio were basically geometrical. Reference is made to the attempts by Antiphon, Bryson and Archimedes to find the value of it. The reason why the symbol π is used to represent the value of this ratio, circumference to diameter, is shown. As mathematicians continue to find values for π, it is noticed that the decimal approximations to the value of π improve. With the development of higher mathematics, the attempts to find the value of π become more sophisticated. The methods of the French mathematician, F. Viète and the Englishman, J. Wallis are described. The German mathematician, G. Leibniz, used a simple expression to find the value of π. A simple experiment is described that enables one to find the approximate value of π. With the aid of computers today, the value of π can be obtained to hundreds of thousands of decimal places.

Suggested Follow-up Activities:

1. The circumference and diameter of various circular objects could be measured and a record kept of the value of this ratio: circumference divided by the diameter.

2. Examine the contributions of some of the mathematicians mentioned during the program: Antiphon, Archimedes, Viète, Fermat, Euler, Gregory, Lindemann.

3. Students could find some approximate values of π by using the methods listed below to more and more terms.

   J. Wallis: $$\frac{\pi}{2} = \frac{2}{1} \times \frac{2}{3} \times \frac{4}{3} \times \frac{4}{5} \times \frac{6}{5} \times \frac{6}{7} \times \frac{8}{7} \times \frac{8}{9} \cdots$$

   G. Leibniz: $$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \cdots$$

4. The following experiment, outlined on the program, could be attempted to find an approximate value for π. Use ten uniform one-inch sticks. On a large piece of paper, mark off parallel lines two inches apart. From a height of about one foot, drop these ten sticks, and record the number of sticks that touch or cross the lines. Repeat this procedure many times. Divide the total number of sticks dropped by the total number that touched or crossed the lines, and an approximate value for π can be obtained.

5. Discuss the nature of the decimal expansion for π. The value of π to 148 decimal places is 3.141 592653589793238462643383279502884197169399375105820974944592307816406286208998628034825342117067982148086513282306647093844609550582231725359408.

References

"An Introduction to the History of Mathematics", Eves, Holt Rinehart, Winston.

2. FROM TIME TO TIME

Program Content

The development of the Gregorian calendar and the attempts of man to bring it into harmony with nature are shown. The early Roman calendar and the revisions of it by Julius Caesar are described. The Romans used only three distinct days of the month; the Kalends,Nones, and Ides, to reckon dates. Two examples are shown: March 2, March 17. The Roman Calendar was not accurate and accumulated errors. In 1582, Pope Gregory corrected this error by deleting ten days from that year, and decreeing that a centurial year would not be a leap year unless divisible by 400. To date, this reform is the last so far. The program ends with an illustration of another proposed calendar, the World Calendar.

Suggested Follow-up Activities:

1. Discuss: a. the origin of the names for the months. (i.e. January after the Roman god, Janus.)
   b. the origin of the names for the days of the week.

2. The following questions could be discussed about our present calendar:

   a. Why has January 31 days, April 30 days etc?
   b. Why is an extra day required every four years in our calendar?
   c. Why has February 28 days today, but the early Roman calendar had 29 days?
   d. When will our next centurial leap year occur?

3. Discuss the advantages and/or disadvantages of our present day calendar and the proposed new "World Calendar".

References

"The Language of Mathematics", Land, Longmans

3. ONE ONE ONE ONE ONE ONE ONE ONE ONE

Program Content

By using his arms and fingers in various positions, early man was able to represent numbers larger than ten. It is believed the Chinese were one of the earliest peoples to use counting rods for computations. These counting rods were grouped in triangular patterns, which were then grouped to form hexagonal bundles. Another aid for computation that developed was the abacus. Grooves to represent ones, tens, hundreds, etc., were drawn in the sand, but later marble was used. Stones were placed in these grooves to represent numbers. Grooves to represent the intermediate values of 5, 50, 500, etc. were made and fewer stones would then be necessary to do computations. The Roman abacus built with slots, and the Chinese sliding-bead abacus are shown. In many parts of the world, abaci are still used for computations.

Suggested Follow-up Activities:

1. Discuss how the fingers and arms held in various positions could be used to represent numbers greater than ten.

2. The students could be encouraged:

   a. to build a simple abacus using sand, or a Chinese sliding-bead abacus,
   b. to do simple arithmetical operations using an abacus.

3. Examine contemporary situations where automatic counting is necessary, eg. turnstiles, printing machines, counters on tape recorders, odometers, etc.

4. Discuss the following from the program:

   a. the use of abaci for computations in some parts of the world,
   b. the origin of the word abacus, calculation,
   c. the use of abaci in banks.

References:

"Enrichment Mathematics" Ripley and Tait, Copp Clark.
"History of Mathematics", (2 Volumes) D.E. Smith, Ginn and Company.

4. ABACUS TO COMPUTER

Program Content

This program traces the development of mechanical aids for computations from the abacus to the computer. In 1642, Blaise Pascal, at the age of 19, developed an adding machine which incorporated automatic carrying in arithmetical operations. The contributions of Gottfried Leibniz, Matteus Hahn, and Charles Babbage are then discussed, and illustrated. With improved technology, calculating machines have progressed to the stage of the compact electrically-powered ones we have today. The computer is the highest achievement reached by man in his efforts to speed up the process of computation. The use of the computer in various phases of transportation, business and science is shown.

Suggested Follow-up Activities:

1. Discuss the contributions of Blaise Pascal, Gottfried Leibniz, Matteus Hahn, Charles Babbage, to name a few, in the development of mechanical aids for computation.

2. The students could be encouraged to build a simple calculating device.

3. Discuss the various areas in which calculators are used. e.g. supermarkets, banks, etc.

4. The various types of punched cards used for telephone, gasoline, credit charges could be examined. The following questions could be considered:

   a. Why are holes necessary in the cards?
   b. What advantages and/or disadvantages may exist for the company that uses them?

5. The areas in which computers are used could be discussed e.g. street traffic, railways, airports, telephone communications, laboratories, space technology, etc.

References:

"Computers 1,2", F.B. Louis, MacMillan.
"Computers", S. Thomas, Holt Rinehart Winston.
"Computers in Business" Kohl, Gage.

5. CENTENNIAL SYMBOL

Program Content

The program opens by illustrating that geometry is found in nature, and used by man in many ways. The Centennial Symbol is then developed by various methods based on the properties of the triangle, regular hexagon, and the rhombus. The program ends with further illustrations of geometric principles involved in buildings, highways, patterns, mosaics etc.

Suggested Follow-up Activities:

1. The centennial symbol could be drawn using the methods illustrated in the program. The geometric properties involved in these constructions could be discussed.

2. Examine geometric forms found in nature, e.g. snowflakes, honeycomb, starfish, leaf patterns, spiders' webs, etc.

3. Discuss the various ways man has used geometry.

4. Various designs could be drawn by using different arrangements of triangles, pentagons, hexagons, etc.

5. The following solids could be built: triangular prisms, icosohedrons, dodecahedrons, etc.

References:

"Enrichment Mathematics", Ripley and Tait, Copp Clark.

6. HISTORY OF NUMERALS

Program Content

The program outlines the development of numerals from the earliest forms to the Hindu-Arabic numerals. Man's first method of recording numbers was probably a tally system using objects such as stones. The ancient Babylonians and Sumerians evolved a method where wedge marks were used in soft clay, which was then baked to obtain a permanent record. The symbols used by the Mayans and Egyptians are then shown. The program then illustrates the numerals written by the Greeks and Romans. The origins and development of the Hindu-Arabic numerals 0,1, ... , 9 are then described. Although the Hindu-Arabic system of numerals is generally accepted today, other systems are still in use, e.g. the Chinese numeral system.

Suggested Follow-up Activities:

1. Discuss the following numeral systems: Babylonian, Sumerian Wedge marks, Mayan, Aztec, Egyptian, Greek, Roman. The students could write numbers using the different systems and do simple calculations with them.

2. Trace the development of the forms and the origins of the Hindu-Arabic numerals, 0,1,2, . . . 9. Why are these numerals referred to as the Hindu-Arabic system?

3. Examine what other systems of numerals are used today.

4. Discuss the following:

   a. Numbers written on some cheques use a special ink which a computer can interpret.
   b. Counting with various combinations of hand and finger formations is still done.
   c. The Hindu-Arabic system of numerals did not gain fast acceptance in the Roman Empire.
   d. Leonardo da Pisa played a considerable part in making the advantages of the Hindu-Arabic system more widely known.

References:

"An introduction to the History of Mathematics", Eves, Holt Rinehart.
"Mathematics", Life Science Library.

7. HISTORY OF INDIAN MATHEMATICS

Program Content

The program opens with a brief note on the contributions of a number of mathematicians. The three periods of Indian Mathematics are then examined: Sulvasutra, ca. 200 AD; Astronomical, ca. 400-600 AD; and Hindu, ca. 600-1200 AD. In the first period, the early development of mathematics is traced. Aryabhata was a mathematician of the second era and his written work influenced the mathematics of the Hindu period. One outstanding mathematician of this period was Brahmagupta who wrote a 21-chapter book on various topics of mathematics. A problem found in the work of Mahaviran the Learned illustrates his fanciful approach to the study of mathematics. e.g. "How many camels were there in this herd if a quarter of a herd of camels is seen in the forest, twice the square root of the herd goes to the slopes, and two times two camels are found on a river bank?" The work of the 19th century Indian mathematician, Ramanujan, is illustrated. He determined the total number of ways a given natural number could be expressed as a sum of smaller whole numbers.

Suggested Follow-up Activities:

1. Examine briefly some of the contributions of the other mathematicians mentioned on the program: Pythagoras, Euclid, Newton, Descartes, Leibniz, Einstein.

2. Discuss the properties of zero with respect to addition, subtraction multiplication, division.

3. Discuss the problem of Mahavira the Learned. (If x represents the number of camels, the equation becomes: $\frac{1}{4}x + 2\sqrt{x} + 4 = x$)

4. Discuss the following as noted in the program:

   a. the problem of squaring the circle.
   b. the volume V of a pyramid in terms of the area A of the base and the height h. ($V = 1/3\ Ah$)
   c. $\pi = 3\ \frac{177}{1250}$ (3.1416)
   d. Pythagoras theorem.
   e. the area of a circle is equal to that of a rectangle having a width equal to the radius, and the length equal to half of the circumference.

References:

"An Introduction to the History of Mathematics", Eves, Holt Rinehart.

8. SHAPES OF NUMBERS

Program Content

The natural numbers are represented by geometrical configurations of dots. Triangular numbers (so called because they can be represented as a triangular array of dots) were studied by the German Mathematician, Carl Gauss - who recognized that each sum of consecutive natural numbers represented a triangular number. Other numbers illustrated on the program are oblong, pentagonal and hexagonal. The numbers found by adding consecutive triangular numbers are represented in the form of tetrahedrons, and thus called tetrahedral numbers. In a similar way, pyramidal numbers are formed. The program ends with two examples of magic squares.

Suggested Follow-up Activities:

1. The following could be discussed:

   a. When consecutive natural numbers are added, the sums obtained represent the triangular numbers 1, 3, 6, 10, ...

   b. When consecutive odd numbers are added, the sums obtained represent the square numbers 1, 4, 9, 16, ...

   c. When consecutive even numbers are added, the sums obtained represent the oblong numbers 2, 6, 12, 20, ...

2. Determine the triangular numbers by using the expression $\frac{1}{2}n(n + 1)$ for the nth one. (In this way, Gauss was able to determine that the sum $1 + 2 + 3 + 4 + \ldots + 100$ represented the 100th triangular number, and easily obtained the value 5050.)

3. By using geometrical configurations, the students could be encouraged to show that:

   a. each square number is the sum of two consecutive triangular numbers,

   b. each oblong number is the sum of two equal triangular numbers.

4. Discuss the following:

   a. Consecutive sums of the numbers 1, 4, 7, 10, . . . are referred to as the pentagonal numbers 1, 5, 12, 22, . . .

   b. Consecutive sums of the numbers 1, 5, 9, 13, . . . are referred to as the hexagonal numbers 6, 15, 28, . . .

5. The geometrical configurations represented by the following numbers could be examined:

   a. tetrahedral numbers - addition of consecutive triangular numbers,

   b. pyramidal numbers - addition of consecutive square numbers,

   c. cubic numbers - addition by the following pattern 1, 3+5, 7+9+11, 13+15+17+19, . . .

6. The magic squares shown on the program are given below for purposes of discussion.

4	9	2
3	5	7
8	1	6

7	12	1	14
2	13	8	11
16	3	10	5
9	6	15	4

7. Man has named numbers in many ways. The following could be discussed: perfect numbers, deficient numbers, abundant numbers, Pythagorean numbers, friendly numbers, unlucky numbers, to name a few.

References:

"An Introduction to the History of Mathematics", Eves, Holt Rinehart Winston.